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(54) IMAGE FORMING APPARATUS INCLUDING A DUCT FILTER HAVING CORRUGATED SURFACE SHAPE

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(58) **Field of Classification Search**
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USPC 399/93
See application file for complete search history.

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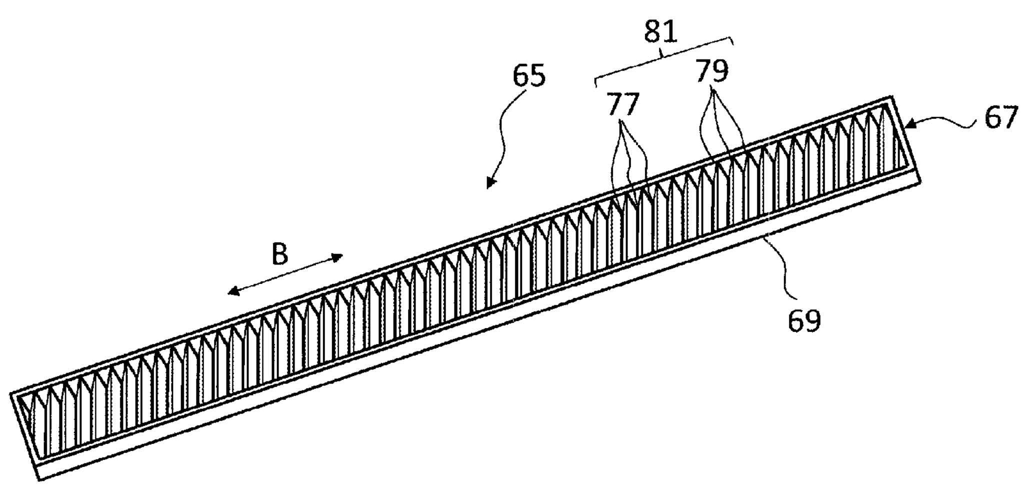
(57) **ABSTRACT**

An image forming apparatus includes a fuser unit which includes a heat roller and a pressure roller; a duct which is formed in a long shape in a direction along an axis of the heat roller, is disposed in the vicinity of the fuser unit along the axis of the heat roller, and is exhausted by an exhaust fan which is provided on one end side in a long-side direction; an exhaust port which is opened to a first side wall of the fuser unit side of the duct and causes the fuser unit and the duct to communicate with each other; and a planar filter which is attached to an inner wall surface of the duct. The filter includes a filter base material having an irregular surface shape in which ditches and convex portions are alternately disposed; and a frame which is bonded to both ends orthogonal to an irregularity direction of the filter base material, the convex portion of the filter base material protrudes from the frame, and the convex portion of the filter base material is bonded or stuck to the inner wall surface.

9 Claims, 9 Drawing Sheets



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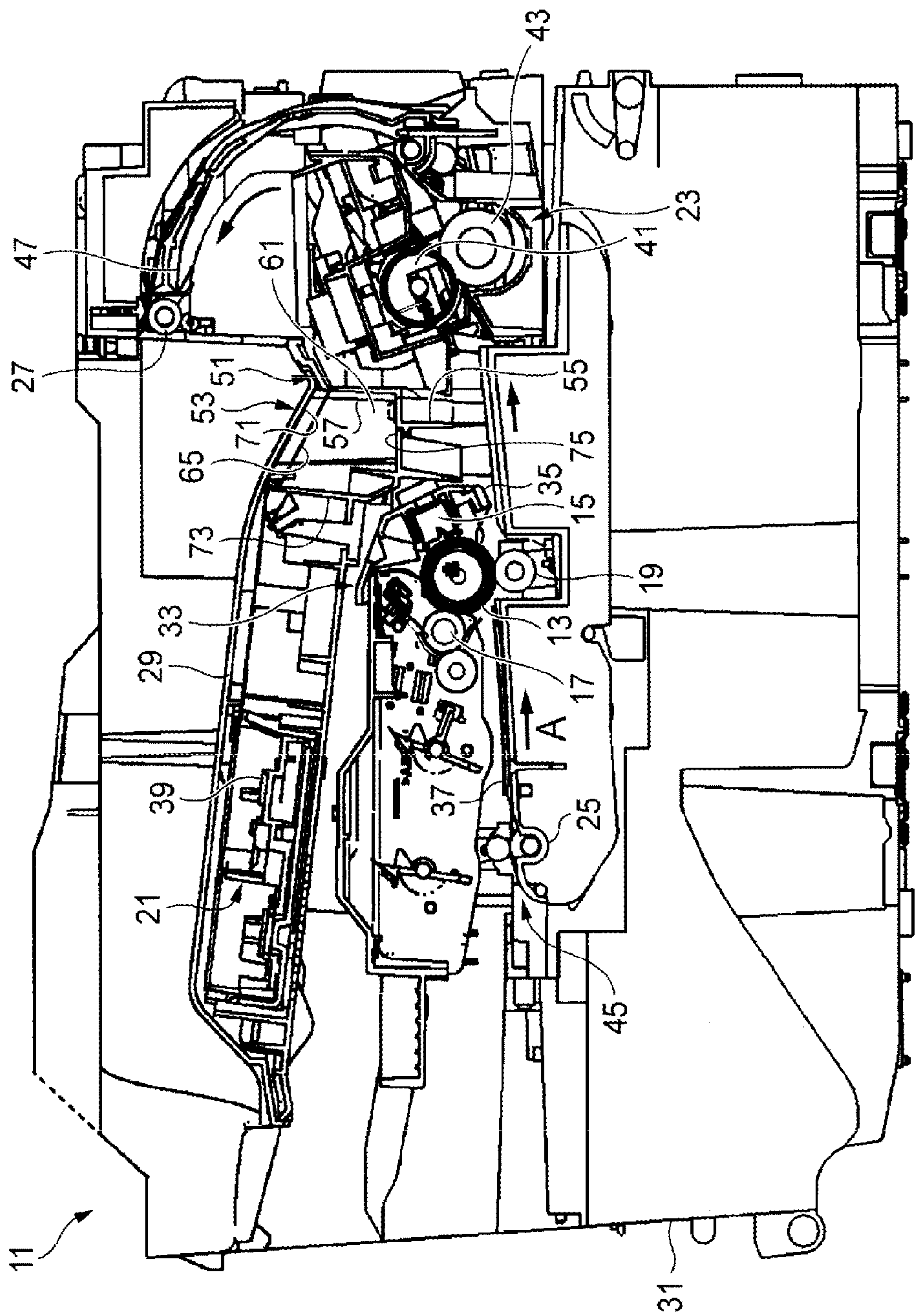
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FIG. 1

FIG. 2

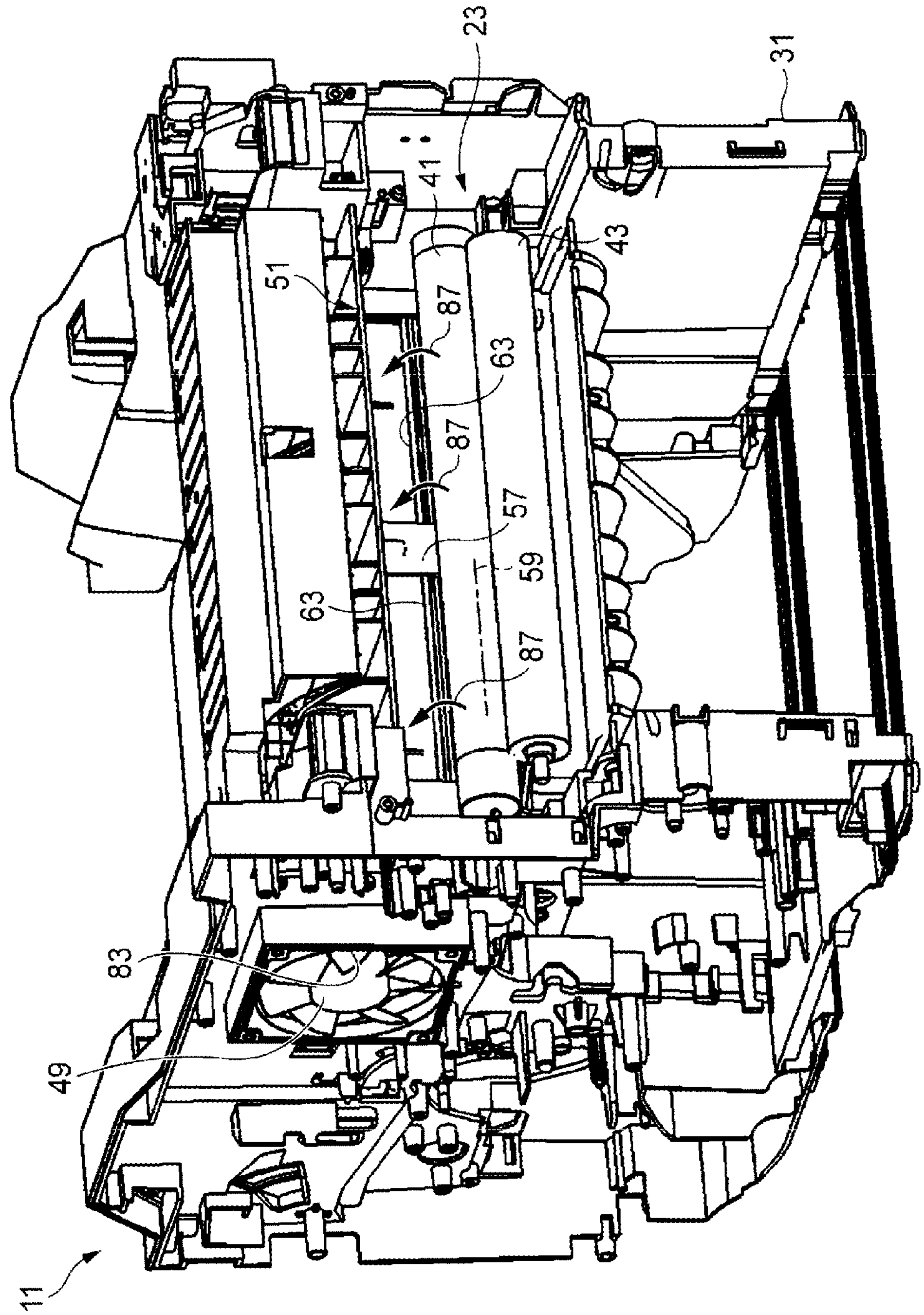

FIG. 3

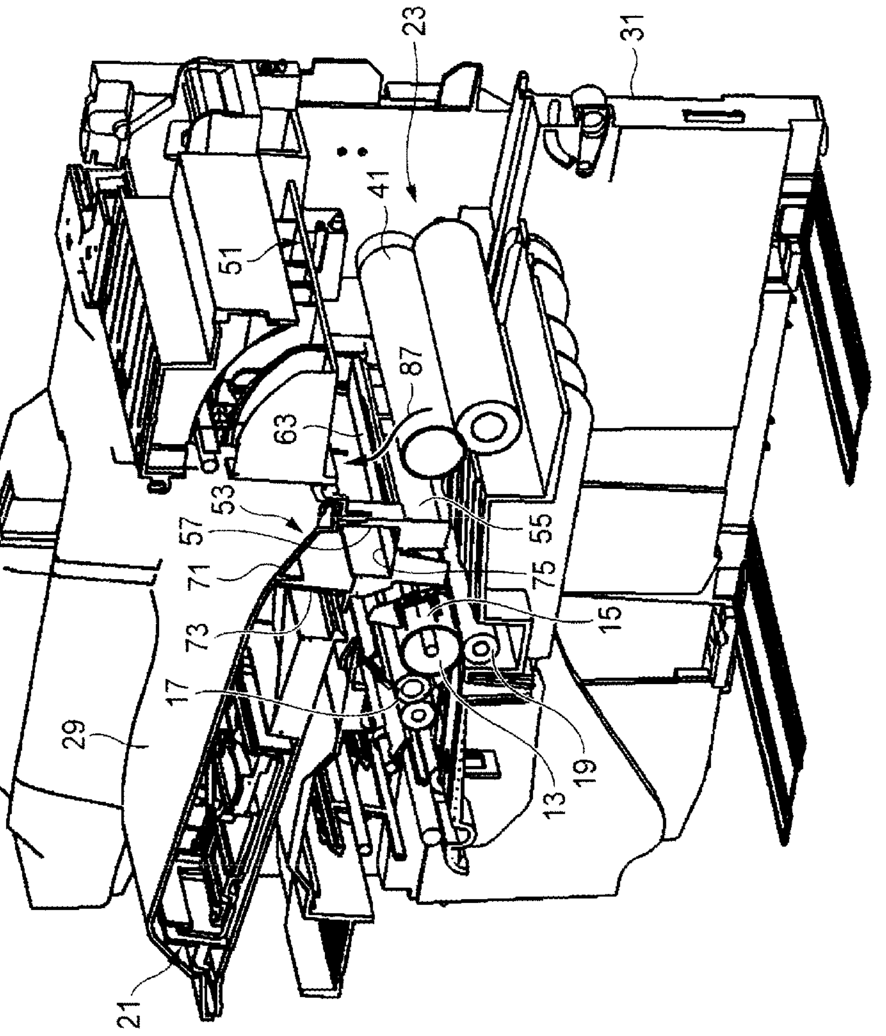

FIG. 4

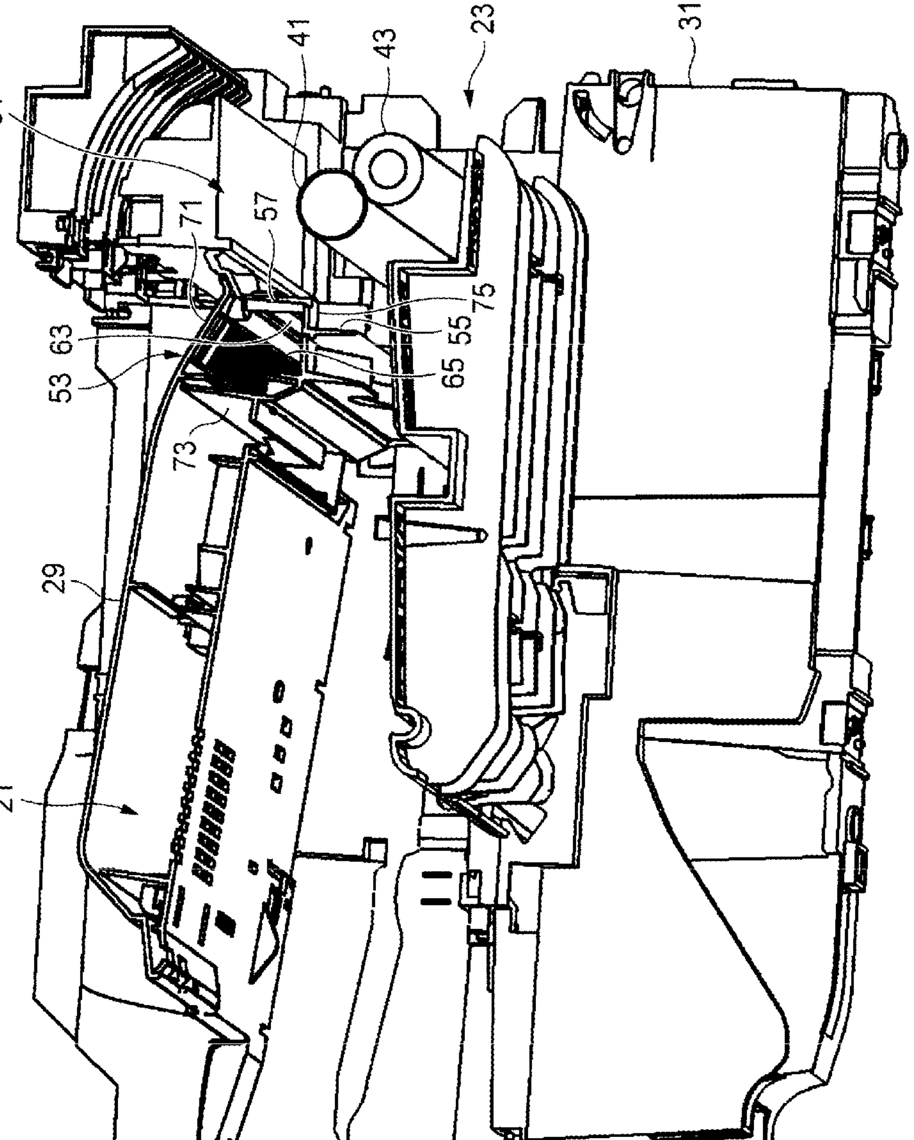

FIG. 5

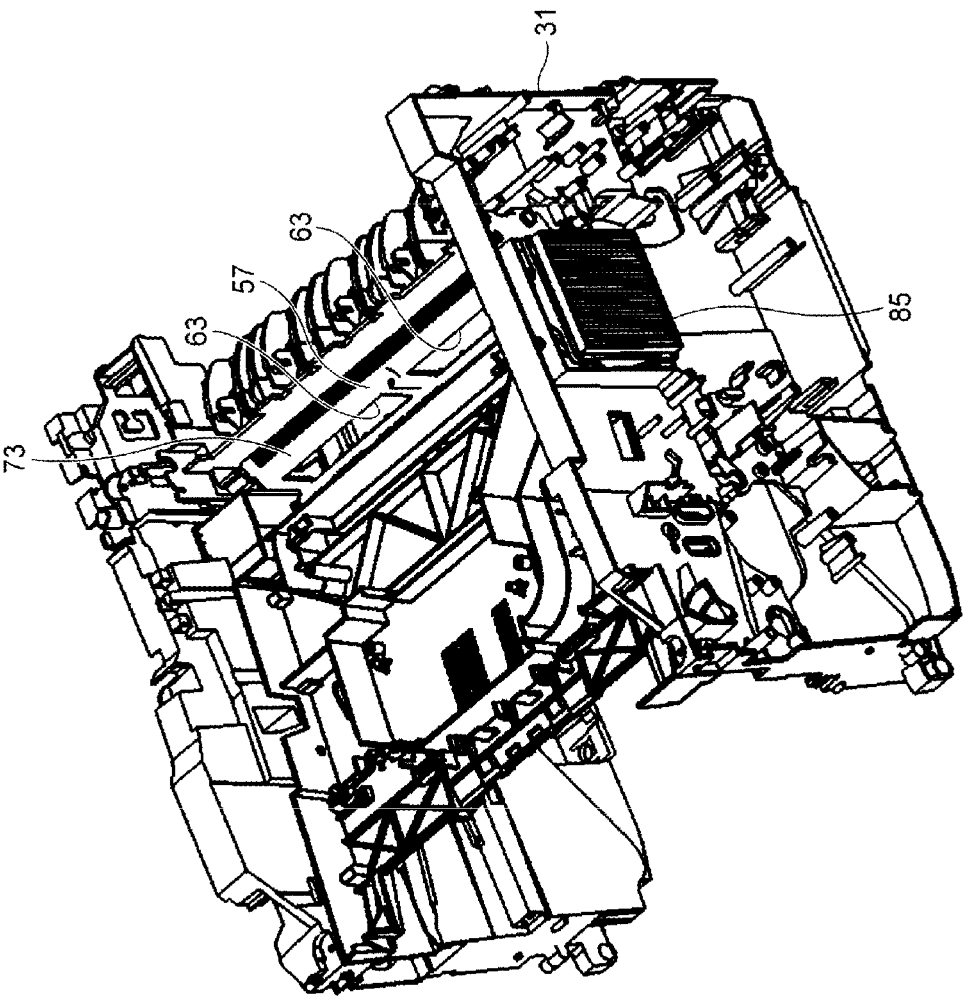

FIG. 6

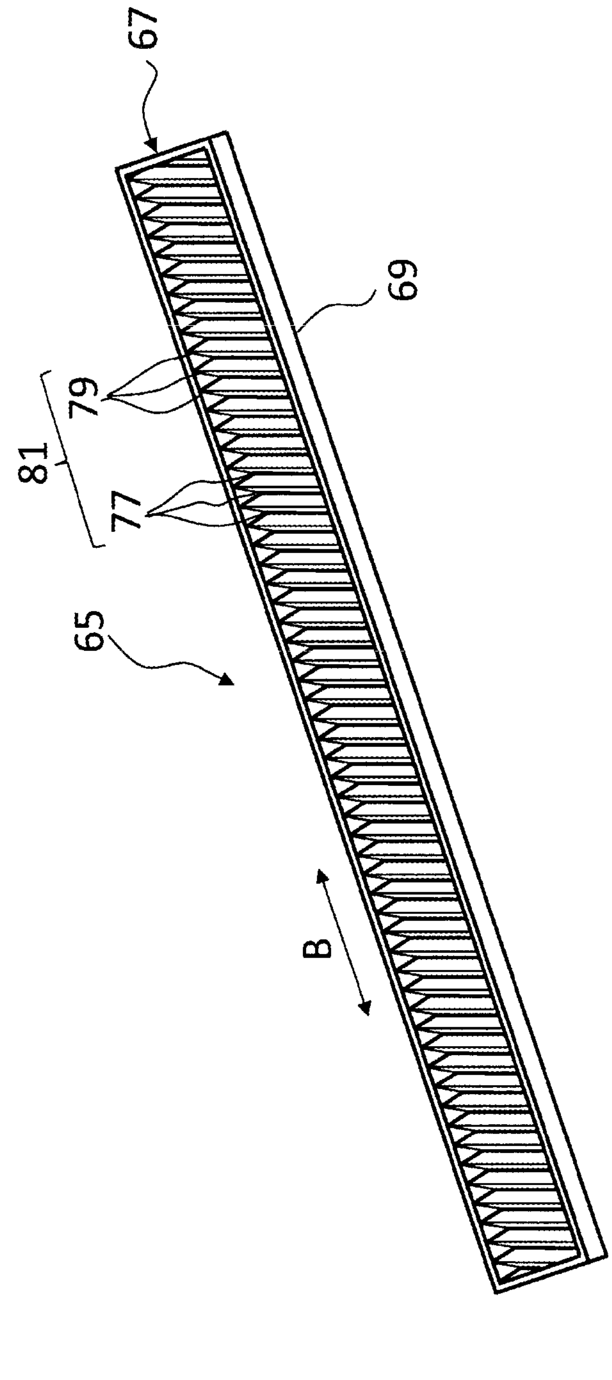

FIG. 7

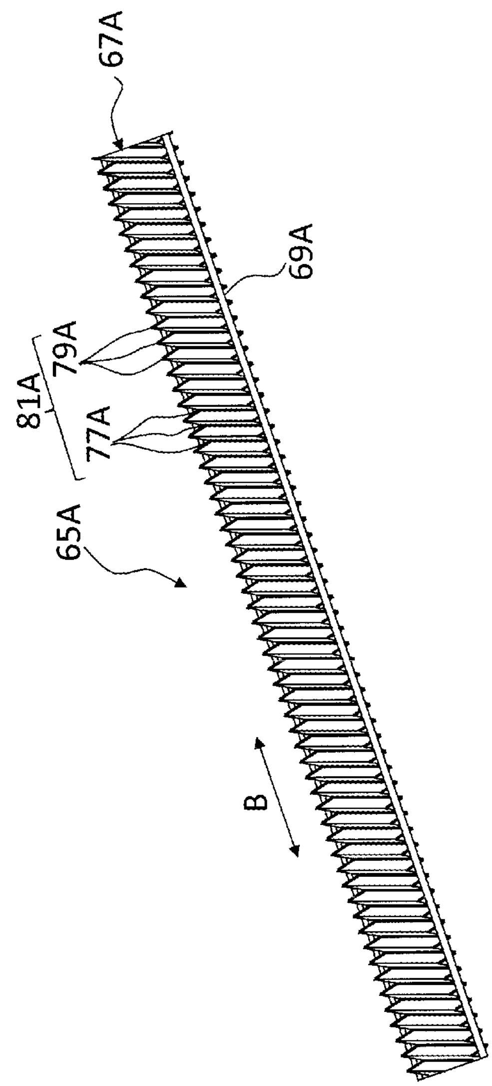

FIG. 8

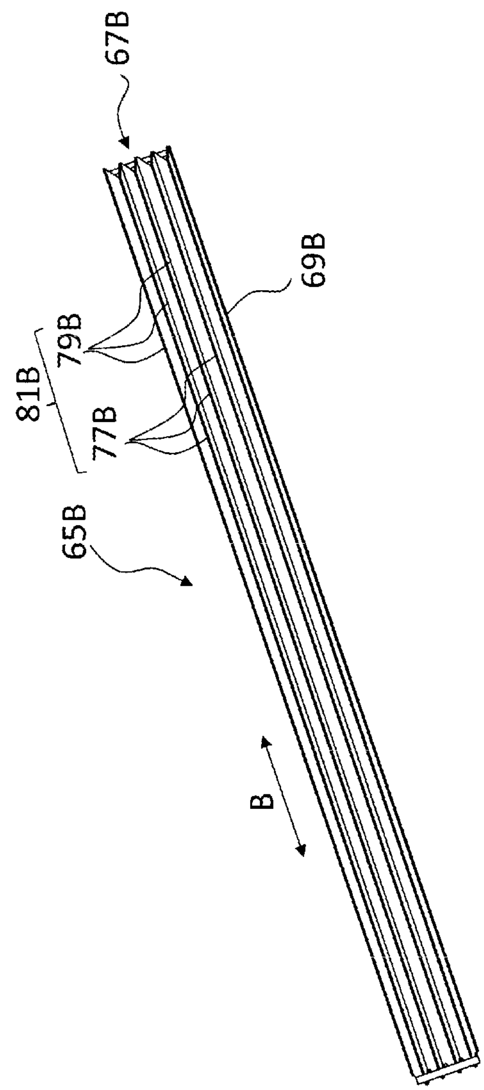

FIG. 9

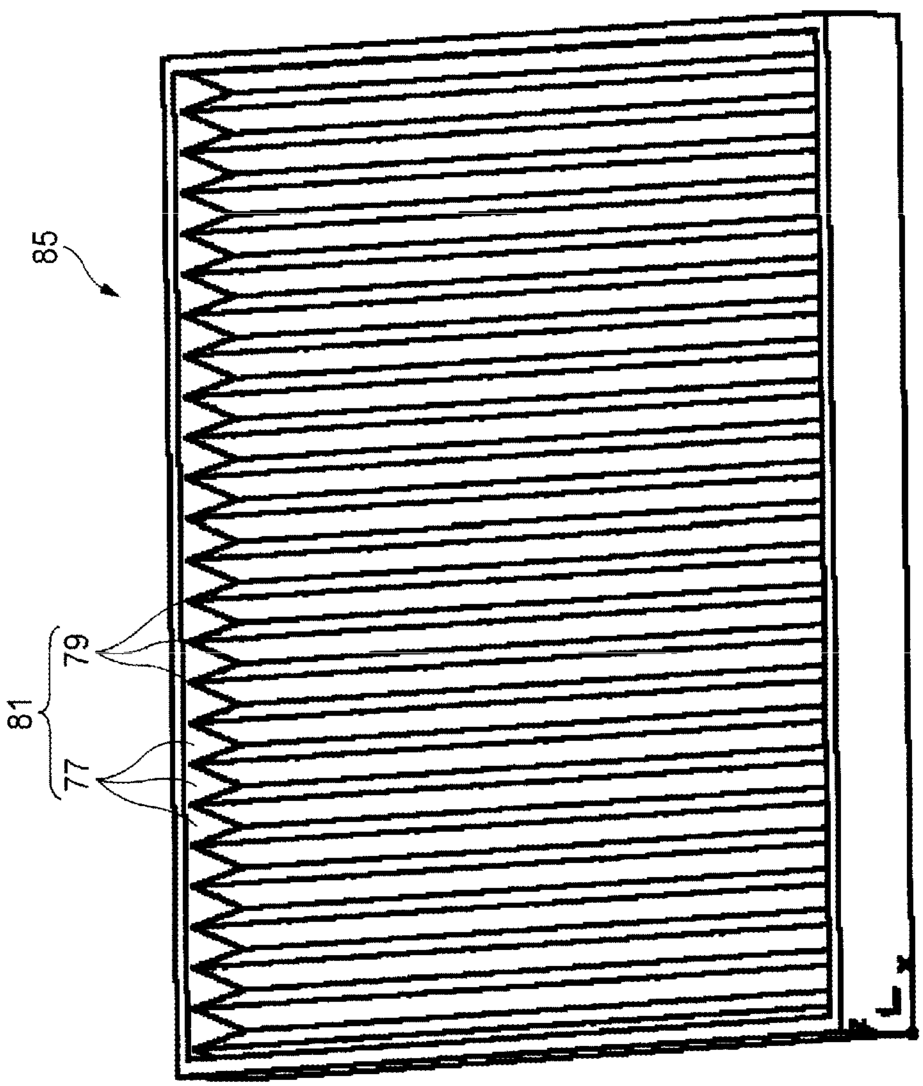

IMAGE FORMING APPARATUS INCLUDING A DUCT FILTER HAVING CORRUGATED SURFACE SHAPE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image forming apparatus.

2. Description of the Related Art

In an electrophotographic image forming apparatus, it is known that a plurality of kinds of chemical substances are discharged from an image forming apparatus during image forming. For example, as a representative of the discharged chemical substances, there is ozone generated when a photosensitive drum is charged, or toner dust generated during developing or fusing. In the related art, in order to not allow the generated chemical substances to be discharged outside the image forming apparatus, for example, a measure of providing a filter or the like is performed.

In a volatile chemical substance collection device of an electronic apparatus disclosed in Japanese Patent Unexamined Publication No. 2009-282455, a technology is disclosed in which an electric field is generated in an atmosphere from an electric field generating collection member in an exhaust duct provided above a fuser unit, and volatile organic compounds (VOC) included in the atmosphere are drawn to the surface of the electronic field generating collection member by the operation of the electric field so as to be collected.

In an image forming apparatus disclosed in Japanese Patent Unexamined Publication No. 2011-180235, a technology is disclosed as follows. That is, a duct which includes a take-in port for taking-in minute particles generated from a heat roller inside a fusing device is provided in the vicinity of the fusing device. An exhaust fan which generates a flow of air from the take-in port toward an outlet is provided in an expansion portion of the duct, and a first filter member is provided on the upstream side of the exhaust fan. The first filter member captures ultrafine particles (for example, siloxane) generated from a rubber layer configuring the fusing device. A shutter which closes a gap between the first filter member and the expansion portion is provided, and a control portion of the image forming apparatus switches a state where the shutter closes a first filter portion and a state where the shutter does not close the first filter portion according to a predetermined initial burst condition.

In an odor removing device of a multi-function image forming apparatus disclosed in Japanese Patent Unexamined Publication No. 2011-180283, a technology is disclosed as follows. That is, a plurality of air passage portions for introducing air inside a housing are formed on a housing bottom portion. Each air passage portion is a cylindrical body in which an inner diameter of the upper portion side inside the housing is smaller than an inner diameter of the housing bottom portion, and an ozone decomposition filter including an ozone decomposition catalyst is disposed on an inner diameter surface of the cylindrical body. A waste liquid absorbing material is disposed on the bottom portion inside the housing, a deodorizing absorbent is disposed on an upper cover inside the housing, and an exhaust port of the air passing through a portion between the waste liquid absorbing material and the deodorizing absorbent is provided on the side surface of the housing.

Japanese Patent Unexamined Publication No. 2002-8943 discloses a technology, in which a filter is pleat-molded into a

cross-sectional wave shape, and thus, a surface area of a filter base material is increased and deodorization performance is improved.

SUMMARY OF THE INVENTION

According to an exemplary embodiment of the present invention, there is provided an image forming apparatus including: a fuser unit which includes a heat roller and a pressure roller which heats and pressurizes a sheet on which an unfused toner image is carried and fuses the unfused toner image on the sheet; a duct which is formed in a long shape in a direction along an axis of the heat roller, is disposed in the vicinity of the fuser unit along the axis of the heat roller, and is exhausted by an exhaust fan which is provided on one end side in a long-side direction; an exhaust port which is opened to a first side wall of the fuser unit side of the duct and causes the fuser unit and the duct to communicate with each other; and a planar filter which is attached to an inner wall surface of the duct, in which the filter includes a filter base material having an irregular surface shape in which ditches and convex portions are alternately disposed and a frame which is bonded to both ends orthogonal to an irregularity direction of the filter base material, and the convex portion of the filter base material protrudes from the frame, and the convex portion of the filter base material is bonded or stuck to the inner wall surface.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a longitudinal cross-sectional view of a multi-function printer of the present embodiment;

FIG. **2** is a perspective view when a first side wall of the multi-function printer shown in FIG. **1** is viewed from a fuser unit container side;

FIG. **3** is a perspective view when FIG. **2** is cut at an approximately center position in a long-side direction of a heat roller;

FIG. **4** is a perspective view when FIG. **3** is viewed from the lower portion of a duct side;

FIG. **5** is a perspective view when an exhaust port of a first side wall is viewed from the upper portion in a state where a ceiling surface of the duct is not shown;

FIG. **6** is a perspective view of a filter in which ditches and convex portions extend so as to be orthogonal to each other in a long-side direction of the duct;

FIG. **7** is a perspective view of a filter in which ditches and convex portions extend in an inclination direction in the long-side direction of the duct;

FIG. **8** is a perspective view of a filter in which ditches and convex portions extend so as to be parallel with each other in the long-side direction of the duct; and

FIG. **9** is a perspective view of a thru-beam type filter.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, an embodiment (hereinafter, referred to as the "present embodiment") of an image forming apparatus according to the present invention will be described with reference to the drawings. In the present embodiment below, as an example of the image forming apparatus according to the present invention, an electrophotographic multi-function printer will be described. However, the image forming apparatus according to the present invention is not limited to the multi-function printer, and for example, may be also applied to a copier or printer.

FIG. **1** is a longitudinal cross-sectional view of multi-function printer **11** of the present embodiment. FIG. **2** is a perspective view when first side wall **57** of multi-function printer **11** shown in FIG. **1** is viewed from fuser unit container **51** side. FIG. **3** is a perspective view when FIG. **2** is cut at an approximately center position in a long-side direction of heat roller **41**. FIG. **4** is a perspective view when FIG. **3** is viewed from the lower portion of duct **53** side. FIG. **5** is a perspective view when exhaust port **63** of first side wall **57** is viewed from the upper portion in a state where ceiling surface **71** of the duct is not shown. FIG. **6** is a perspective view of filter **65** in which ditches **77** and convex portions **79** extend so as to be orthogonal to each other in a long-side direction of duct **53**. FIG. **7** is a perspective view of filter **65**A in which ditches **77**A and convex portions **79**A extend in an inclination direction in the long-side direction of duct **53**. FIG. **8** is a perspective view of filter **65**B in which ditches **77**B and convex portions **79**B extend so as to be parallel with each other in the long-side direction of duct **53**. FIG. **9** is a perspective view of thru-beam type filter **85**.

For example, multi-function printer **11** of the present embodiment includes functions such as scanning, copying, or printing, form (fuses) a monochromatic or multicolor image on a sheet (for example, a recording material or a recording sheet) based on print job data input from an external device (for example, a personal computer (PC) (not shown)), and discharges the sheet.

Multi-function printer **11** shown in FIG. **1** is configured to include at least photosensitive drum **13**, charging unit **15**, developing roller **17**, transfer roller **19**, exposure device **21**, fuser unit **23**, sheet feeding cassette (not shown), sheet transport roller **25**, sheet discharging roller **27**, and sheet discharging tray **29** in main body casing **31**.

For example, one set of visible image forming units (process units) **33** is disposed at an approximately center inside main body casing **31** of multi-function printer **11** shown in FIG. **1**. For ease of explanation, for example, it is described that one set of visible image forming units **33** is disposed to form a black image in multi-function printer **11** shown in FIG. **1**. However, the visible image forming unit having the similar configuration for each different color (yellow, magenta, cyan) may be disposed.

Photosensitive drum **13** which has a role as an electrostatic latent image carrier according to print job data input into multi-function printer **11** is provided in visible image forming unit **33**, and charging unit **15**, developing roller **17**, transfer roller **19**, and cleaning unit **35** are disposed in the vicinity of photosensitive drum **13**.

Charging unit **15** uniformly charges a predetermined potential (for example, negative potential) on the surface of photosensitive drum **13**. For example, preferably, charging unit **15** is a charge roller type which can uniformly charge the surface of photosensitive drum **13** without generating ozone as much as possible during charging with respect to photosensitive drum **13**. However, charging unit **15** is not limited to the charge roller type, and for example, may use a contact type brush or a non-contact charger type.

Developing roller **17** develops electrostatic latent image formed on photosensitive drum **13** by exposure device **21** described below using toner supplied to developing roller **17**. Accordingly, a toner image corresponding to the print job data is obtained. In the present embodiment, for example, black toner is supplied to developing roller **17**. In multi-function printer **11**, toner of each color may be supplied to each developing roller of a visible image forming unit corresponding to each color of yellow, magenta, and cyan, and having the same configuration as the visible image forming unit **33**.

Transfer roller **19** is disposed to oppose photosensitive drum **13**, and transfers the toner image formed on the surface of photosensitive drum **13** to sheet **37** which is transported along sheet transport path **45**. Hereinafter, the toner image transferred to sheet **37** by transfer roller **19** is referred to as an "unfused toner image".

Cleaning unit **35** removes and recovers the toner which remains on the surface of photosensitive drum **13** after the transfer processing is performed in transfer roller **19**.

Exposure device **21** includes a laser scanning unit (LSU) **39**. Laser scanning unit **39** is configured to include a laser light source, a polygon mirror which performs scanning with the laser light emitted from the laser light source, a lens which introduces the laser light which performs the scanning by the polygon mirror into photosensitive drum **13**, and a reflecting mirror. Laser scanning unit **39** exposes the surface of photosensitive drum **13** by the light from the polygon mirror according to the input print job data, and forms the electrostatic latent image according to the print job data on photosensitive drum **13**.

Fuser unit **23** is configured to include heat roller **41** and pressure roller **43** which extend so as to be perpendicular to sheet **37**. Heat roller **41** is heated to a predetermined target temperature (for example, fuse temperature within a range from 180° C. to 200° C.) by a heater which is a heat source. Pressure roller **43** is biased toward heat roller **41** by a spring (not shown). Fuser unit **23** heats and pressurizes sheet **37** to which the toner image is transferred in pressure roller **43** and heat roller **41**, and thus, the unfused toner image is fused on sheet **37**.

Sheet transport path **45** is formed from a sheet feeding cassette (not shown) to sheet discharging tray **29** in main body casing **31**. Sheet transport path **45** is configured of a transport path which passes through fuser unit **23** from sheet transport roller **25** via a portion between photosensitive drum **13** and transfer roller **19**, and reaches sheet discharging roller **27** (refer to an arrow A in FIG. **1**). Sheet transport path **45** becomes sheet discharging path **47** immediately before sheet discharging roller **27**. For example, a switchback transport path (not shown) for feeding sheet **37** to the position of transfer roller **19** again when a duplex printing is performed is provided in sheet discharging path **47**.

A control portion (not shown) for integrally controlling all operations of multi-function printer **11** is provided in main body casing **31**. The control portion is configured using a processor (for example, Central Processing Unit (CPU), Micro Processing Unit (MPU), and Digital Signal Processor (DSP)). The control portion controls each operation in each portion of multi-function printer **11**, that is, photosensitive drum **13**, charging unit **15**, developing roller **17**, transfer roller **19**, exposure device **21**, fuser unit **23**, sheet transport roller **25**, and sheet discharging roller **27**. Control portion also controls the operation of exhaust fan **49** (refer to FIG. **2**) described below.

In multi-function printer **11** having the above-described configuration, an image forming process is performed as follows by control portion of multi-function printer **11**.

When the image forming is performed, first, sheets **37** are discharged from a sheet feeding cassette (not shown) to sheet transport path **45** one by one using sheet transport roller **25**.

After charging unit **15** uniformly charges the surface of photosensitive drum **13**, exposure device **21** exposes a charge region on the surface of photosensitive drum **13** by laser light according to the print job data input from the external device.

Accordingly, the electronic latent image corresponding to the print job data is formed on the surface of photosensitive drum **13**. Continuously, developing roller **17** develops the electronic latent image formed on the surface of the photosensitive drum **13** using the toner supplied by developing roller **17**. Accordingly, the toner image corresponding to the print job data is obtained.

Transfer roller **19** transfers the toner image formed on the surface of photosensitive drum **13** to sheet **37** which is fed from the sheet feeding cassette (not shown) by sheet transport roller **25** and is transported. Accordingly, the unfused toner image corresponding to the print job data is transferred to sheet **37**. The unfused toner image transferred to sheet **37** is transported to fuser unit **23**. Fuser unit **23** sufficiently heats and pressurizes the unfused toner image in heat roller **41** and pressure roller **43** and fuses the unfused toner image on sheet **37**. Accordingly, the image corresponding to the print job data is formed on sheet **37**, and sheet **37** is discharged to sheet discharging tray **29** by sheet discharging roller **27**.

Here, in multi-function printer **11** of the present embodiment, fuser unit container **51** for accommodating fuser unit **23** is provided in the vicinity of fuser unit **23**. Fuser unit container **51** is formed as a cavity which has airtightness on a level in which the ultrafine particles (UFP) generated inside fuser unit container **51**, that is, in fuser unit **23** are not leaked to the outside of fuser unit container **51**.

More specifically, fuser unit container **51** is formed by connecting a plurality of metal plates and molding resin plates fixed to main body casing **31** to one another. Since fuser unit container **51** becomes a negative pressure by suction of exhaust fan **49** described below, existence of a small gap such as sheet transport path **45** communicating with the outside of the cavity is admitted. Outside air flows into fuser unit container **51** from the gap, and thus, fuser unit container **51** does not become a vacuum. An exclusive air feeding port may be provided in fuser unit container **51**.

Duct **53** is provided so as to be adjacent to fuser unit container **51**. Duct **53** is formed in a long shape in a direction along axis **59** (refer to FIG. **2**) of heat roller **41**, and is disposed in the vicinity of fuser unit **23** along axis **59** of heat roller **41**. More specifically, duct **53** is formed in a long shape in the direction along axis **59** (refer to FIG. **2**) of heat roller **41** with a portion of wall portion **55** in fuser unit container **51** as first side wall **57**. Exhaust fan **49** (refer to FIG. **2**) is provided on one end side in a long-side direction of duct **53**, and exhaust fan **49** exhausts exhaust emissions including air existing in air transport space **61** (refer to FIG. **1**) of duct **53** to the outside of main body casing **31**.

Exhaust port **63** (refer to FIG. **2**) is opened to first side wall **57** of fuser unit **23** side of duct **53**, that is, first side wall **57** of wall portion **55** of fuser unit container **51**. Exhaust port **63** causes fuser unit **23** and duct **53** to communicate with each other. More specifically, exhaust port **63** causes fuser unit container **51** which is provided so as to cover fuser unit **23** and duct **53** to communicate with each other. In the present embodiment, as shown in FIG. **2**, a plurality of (two in FIG. **2**) exhaust ports **63** are formed in the long-side direction of first side wall **57**. A gap between exhaust ports **63** and an opening area of each exhaust port are set after container exhaust gas **87** described below is adjusted so as to be exhausted without variation in the long-side direction of fuser unit container **51**.

Planar filter **65** is detachably attached to the inner wall surface of duct **53** so as to be parallel with inner wall surface. Since filter **65** is disposed so as to be parallel with the inner wall surface, it is possible to easily perform direct fixation with respect to the inner wall surface using a bonding agent, a double-sided adhesive tape, or the like. In duct **53**, since filter **65** is directly fixed to the inner wall surface, a decrease in air transport space **61** is suppressed to the minimum. The inner wall surface of duct **53** is used as a collective name of ceiling surface **71**, first side wall **57**, second side wall **73**, and bottom surface **75** of the duct.

As shown in FIG. **6**, filter **65** includes filter main body **67** which is a filter base material formed in the shape of irregular surface **81**, and frame body **69** which is a frame. In filter main body **67**, ditches **77** and convex portions **79** are alternately disposed. Frame body **69** is bonded to both ends orthogonal to an irregularity direction of filter main body **67**. Ditches **77** and convex portions **79** of filter main body **67** protrude from frame body **69**. "Both ends orthogonal to the irregularity direction" are a pair of ends which is positioned on both sides toward a direction in which irregularities are arranged. Frame body **69** is fixed to both ends of filter main body **67**.

For example, in the configuration of filter **65** of the present embodiment, ditches **77** and convex portions **79** are formed of V grooves, and crest portions in which V grooves are vertically inverted. The lowest portion of the V groove becomes a valley bottom at which a pair of valley surfaces crosses each other. The highest portion of the crest portion is an apex at which a pair of inclined sides crosses each other. Since filter main body **67** is formed to be folded upwardly or downwardly, the valley bottom and the apex have opposite phases on the front and rear surfaces. That is, the valley bottom on the front surface becomes the apex on the rear surface.

Frame body **69** of filter **65** may be formed of band shaped non-woven fabrics. Since frame body **69** is formed of non-woven fabrics, in addition to filter main body **67**, lots of minute voids, that is, fiber clearances and holes are also formed in frame body **69**. Accordingly, compared to a case where frame body **69** is formed of materials such as metal or resin which are not non-woven fabrics, in filter **65**, it is possible to increase efficiency of the entire filter **65** of capturing ultrafine particles.

In duct **53**, a rectangular ceiling surface (ceiling surface **71** of the duct) of duct **53** in which the inner wall surface is along the long-side direction of duct **53** is formed. Filter **65** is attached so as to be parallel with ceiling surface **71** of the duct. Specifically, preferably, filter is installed in a rectangular shape which covers ceiling surface **71** of the duct. As a result, if filter **65** has an area which can cover almost the entire ceiling surface **71** of the duct, filter **65** may be a single filter or a plurality of divided filters.

Filter **65** may be installed to cover all or a portion of first side wall **57**, second side wall **73**, and bottom surface **75** in addition to ceiling surface **71** of the duct. However, when filter **65** is provided on first side wall **57**, filter is provided on a portion other than exhaust port **63** so that exhaust port **63** is not blocked.

Ceiling surface **71** of the duct is formed to be upwardly inclined so as to be heightened as ceiling surface **71** is away from exhaust port **63**. In first side wall **57** and second side wall **73** opposing first side wall which are positioned in a state where ceiling surface **71** of the duct is interposed therebetween, an included angle between first side wall **57** and ceiling surface **71** and an included angle between second side wall **73** and ceiling surface **71** become acute angles.

As shown in FIG. **6**, the surface of filter **65** is configured so as to have irregular surface **81** in which ditches **77** and convex portions **79** parallel with each other to be extended so as to be orthogonal to the long-side direction of duct **53** are alternately disposed in the long-side direction (arrow B direction in FIG. **6**) of ceiling surface **71** of the duct. Since filter **65** has irregular surface **81**, the surface area is increased.

Ditch **77** and convex portion **79** configuring irregular surface **81** may be formed in various shapes. For example, although it is not shown, ditch **77** may be formed in a V ditch, and convex portion **79** may be formed in an inverted V-shaped crest. Although it is not shown, in ditch **77** and convex portion **79**, a valley bottom of the V groove and an apex of the inverted-V shaped crest are curved, and a so-called waveform of a sine wave shape may be configured. Although it is not shown, ditch **77** and convex portion **79** may be a recessed groove having a flat groove bottom and a protruding convex portion **79** having a flat apex.

In filter **65**, ditches **77** and convex portions **79** of irregular surface **81** may be arranged in a different pattern.

As shown in FIG. **7**, the surface of filter **65**A may be irregular surface **81**A in which ditches **77**A and convex portions **79**A extending in a direction inclined in the long-side direction of duct **53** are alternately disposed in the long-side direction of ceiling surface **71** of the duct. A pair of frame body **69**A is parallel with each other on both ends in the extension directions of ditches **77**A and convex portions **79**A extending in the inclination direction, and is bonded to each other while filter main body **67**A is interposed therebetween.

As shown in FIG. **8**, the surface of filter **65**B may be irregular surface **81**B in which ditches **77**B and convex portions **79**B extending in parallel in the long-side direction of duct **53** are alternately disposed in the short-side direction of ceiling surface **71** of the duct. A pair of frame body **69**B is parallel with each other on both ends in the extension directions of ditches **77**B and convex portions **79**B extending in parallel with each other, and is bonded to each other while filter main body **67**B is interposed therebetween.

In the present embodiment, thru-beam type filter **85** shown in FIGS. **5** and **9** is attached so as to cover exhaust opening surface **83** (refer to FIG. **2**) of exhaust fan **49**. As shown in FIG. **9**, the surface of thru-beam type filter **85** is also formed to have irregular surface **81** in which ditches **77** and convex portions **79** parallel with each other are alternately disposed. Since thru-beam type filter **85** has irregular surface **81**, the surface area is increased. Thru-beam type filter **85** passes container exhaust gas **87** (see below) which flows into via exhaust port **63**. Similar to filter **65**, thru-beam type filter **85** is also detachably attached to exhaust opening surface **83**.

Next, an operation of multi-function printer **11** having the above-described configuration will be described.

In multi-function printer **11**, the unfused toner image corresponding to the print job data input from the external device is transferred to sheet **37** and is transported to fuser unit **23**. In fuser unit **23**, sheet **37** is held by heat roller **41** and pressure roller **43**. The unfused toner image carried to sheet **37** becomes an image fused on sheet **37** and is fused by heating of heat roller **41** and pressurizing of pressure roller **43**.

At this time, in fuser unit **23**, it is known that a very small quantity of toner configuring the unfused toner image is separated from the unfused toner image along water vapor according to vaporization of water included in sheet **37**. In general, the toner is configured of pigment, wax, and an external additive. A primary effect of the external additive is to improve response efficiency between the external additive and static electricity, and for example, is used to attach minute particles such as silica on the toner surface. In recent years, there is a report that it is considered that the external additive particularly separated along with water vapor is one of factors increasing ultrafine particles (UFP) in multi-function printer **11**.

In the present embodiment, the external additive separated from the toner surface along with the water vapor generated during the fusing of sheet **37** is carried to the upper portion of fuser unit container **51** along with air which is moved by natural convection and a suction force by exhaust fan **49**. First side wall **57** which is a portion of wall portion **55** is positioned on the upper portion of fuser unit container **51**. First side wall **57** becomes a partition between duct **53** provided to be adjacent to fuser unit container **51** and first side wall. Duct **53** is formed in a long shape in the direction along axis **59** of heat roller **41**. That is, duct **53** is disposed to be adjacent in parallel with fuser unit **23** across the partition, and thus, compactification of multi-function printer **11** is realized. Exhaust port **63** is formed on first side wall **57** which is the partition, and exhaust port **63** causes the inside of fuser unit container **51**, that is, an exposure space of fuser unit **23**, and the inside (air transport space **61**) of duct **53** to communicate with each other.

In duct **53**, the air of air transport space **61** flows toward one end side in the long-side direction by exhaust fan **49** which is provided on one end side in the long-side direction. Accordingly, the air inside fuser unit container **51** is sucked into and flows into air transport space **61** of duct **53** which reaches a negative pressure via exhaust port **63**. The external additive (ultrafine particles: UFP) separated from the toner surface along with the water vapor generated during the fusing of sheet **37** is mostly included in suction air (hereinafter, referred to as "container exhaust gas") along with other volatile organic compounds (VOC) and dust, and flows into air transport space **61** of duct **53**.

When container exhaust gas **87** shown in FIGS. **2** and **3** is transferred to one end side in the long-side direction of duct **53**, the container exhaust gas comes into contact with the surface of planar filter **65** which is attached in parallel with the inner wall surface of duct **53**. Filter **65** and container exhaust gas **87** come into contact with each other, and thus, it is confirmed that the ultrafine particles (UFP) included in container exhaust gas **87** are captured by filter **65**. Specifically, it is possible to confirm the capturing of ultrafine particles by measuring the amount of emission of the ultrafine particles at the outlet side of exhaust fan **49** when filter **65** is provided in duct **53** and when filter **65** is not provided in duct **53**. It is considered that the reason why the ultrafine particles are captured by filter **65** disposed in parallel with container exhaust gas **87** is because container exhaust gas **87** becomes turbulent in the vicinity of the surface of filter **65** and as a result, a vortex is generated, and thus, the ultrafine particles are caught on the surface of filter **65** and therefore, are captured.

In filter **65**, as the base material, vegetable fibers, mineral fibers, synthetic fibers, woven fabrics, non-woven fabrics, felts, webs, resin foamed bodies, porous films, or the like may be used. Even when any base material is used, lots of minute voids, that is, fiber clearances and holes are formed on the surface of filter **65**.

In a portion in which container exhaust gas **87** flowing to air transport space **61** of duct **53** is far away from filter **65**, the container exhaust gas uniformly flows and thus, a velocity gradient (velocity change) is not generated. Meanwhile, since sliding is not generated on the surface of filter **65**, flow velocities are continuously changed by influence of a friction force in the vicinity of filter **65**, and a region in which uniform flow is generated is formed. That is, a thin layer (boundary layer) having a great velocity gradient is covered on the surface of filter **65**. It is considered that the ultrafine particles, in which transport energy is decreased by the boundary layer and the above-described vortex generated by the turbulence, are caught on minute voids on the filter surface and are captured. The boundary layer is changed by ultrafine particles (UFP) which are captured and deposited. It is considered that there are optimal values with respect to a relationship between the ultrafine particles (UFP) and the sizes of the minute voids, and the flow velocity of container exhaust gas **87**.

In this way, in the present embodiment, since duct **53** is disposed in the vicinity of fuser unit **23** along axis **59** of heat roller **41**, a wasteful space is not generated in multi-function printer **11**. As a result, the configuration itself of multi-function printer **11** becomes simple and compact.

More specifically, in the present embodiment, duct **53** is also used as a portion of wall portion **55** of fuser unit container **51**, and thus, it is possible to easily manufacture multi-function printer **11**. Since duct **53** is disposed to be adjacent to fuser unit container **51** along (in parallel with) heat roller **41** only across the partition, wasteful space is not generated in multi-function printer **11**. As a result, the configuration itself of multi-function printer **11** becomes simple and compact. It is also possible to easily replace filter **65**, and thus, it is possible to improve maintenance of multi-function printer **11**.

Since filter **65** is configured in a long shape along the long-side direction of duct **53**, a contact time between container exhaust gas **87** and the filter is lengthened, probability of the ultrafine particles (UFP) being captured is increased, and it is possible to decrease the amounts of the ultrafine particles (UFP) exhausted to the outside of multi-function printer **11**. Filter **65** does not cross air transport space **61** of duct **53**, and is installed in parallel with the transport direction of container exhaust gas **87** in air transport space **61**. Accordingly, unlike the thru-beam type filter in the related art, filter **65** can prevent an increase of resistance when air is transported, and in other words, filter **65** can prevent an increase of output of the exhaust fan.

In multi-function printer **11**, filter **65** is installed on ceiling surface **71** of the duct, and thus, it is possible to allow container exhaust gas **87** including the water vapor generated during the fusing of sheet **37** and ultrafine particles (UFP) having buoyancy generated by ascending current to effectively come into contact with filter **65**. Particularly, since container exhaust gas **87** immediately after exhaust fan **49** is stopped is moved at a low flow velocity in the vicinity of ceiling surface **71** of the duct and thereafter, the container exhaust gas stagnates, it is possible to effectively capture the ultrafine particles (UFP).

In multi-function printer **11**, ceiling surface **71** of the duct is formed to be upwardly inclined so as to be heightened as ceiling surface **71** is away from exhaust port **63**, and the included angle between second side wall **73** and ceiling surface **71** of the duct becomes an acute angle. Accordingly, air transport space **61** interposed between second side wall **73** and filter **65** becomes a corner space which is gradually narrowed toward the upper portion. In the corner space, by friction forces of second side wall **73** and filter **65**, the flow velocity during the exhaust is gradually decreased toward the inner side which is the side remote from exhaust fan **49**. It is assumed that container exhaust gas **87** including the ultrafine particles (UFP) which moves upwardly along with the water vapor ascends toward the corner space. Accordingly, it is possible to deposit the ultrafine particles (UFP) on filter **65** from the inner side of the corner space. As a result, it is possible to effectively use the surface of filter **65** from the inner side of the corner space.

In multi-function printer **11**, filter **65** having irregular surface **81** in which ditches **77** and convex portions **79** are alternately disposed is installed in the transport direction of container exhaust gas **87**. Transported container exhaust gas **87** repeatedly collides with ditches **77** and convex portions **79**, and thus, a vortex is generated. Accordingly, in filter **65**, it is possible to improve probability of the ultrafine particles (UFP) being captured by minute voids of filter **65** itself.

In multi-function printer **11**, the plurality of exhaust ports **63** are provided, and the gap and the area of each exhaust port **63** are appropriately set. Accordingly, compared to a case where one exhaust port **63** is provided, it is possible to suppress variation in an inflow amount of container exhaust gas **87** flowing in air transport space **61** of duct **53** in the long-side direction of duct **53**.

In multi-function printer **11**, container exhaust gas **87** passes through air transport space **61** of duct **53**, and thus, container exhaust gas **87** including the exhaust emissions from fuser unit **23** is exhausted from exhaust opening surface **83** of exhaust fan **49** in a state where the ultrafine particles (UFP) are decreased. At this time, container exhaust gas **87** including the exhaust emissions from fuser unit **23** passes through thru-beam type filter **85**, and thus, the remaining ultrafine particles are captured again. Thru-beam type filter **85** is provided over the entire cross-section of duct **53**, and thus, it is possible to capture ultrafine particle secondarily. Filter **65** inside duct **53** and thru-beam type filter **85** may be installed so that filter performance is appropriately adjusted. For example, a replacement period of filter **65** inside duct **53** may be set to be lengthened, and a replacement period of thru-beam type filter **85** may be set to be shortened.

Here, in the configuration of the related art in which filter **65** is not provided in duct **53**, the decrease of the ultrafine particles (UFP) is dependent on only thru-beam type filter **85**. In this case, when thru-beam type filter **85** is thickened to improve capture performance of ultrafine particles (UFP), exhaust fan **49** having greater power is required, and thus, noise is also increased.

In contrast, in multi-function printer **11** of the present embodiment including filter **65** in duct **53**, thru-beam type filter **85** may have an auxiliary performance. Accordingly, in multi-function printer **11** of the present embodiment, air resistance is not increased even when thru-beam type filter **85** is attached, and it is possible to suppress an increase in the output of exhaust fan **49**.

In filter **65**, filter main body **67** is formed in the irregular shape in which ditches **77** and convex portions **79** are alternately disposed. Frame body **69** is bonded to both ends orthogonal to an irregularity direction of filter main body **67**. "Both ends orthogonal to the irregularity direction" are a pair of ends which is positioned on both sides toward a direction in which irregularities are arranged. Since frame body **69** is fixed to both ends of filter main body **67**, extension and contraction, for example, of the filter **65** are regulated like an accordion, in the irregularity direction. That is, in filter **65**, pitch of the irregularities (ditch **77** (convex portion **79**) and ditch **77** (convex portion **79**)) is not easily changed, and optimal pitch is always maintained. Accordingly, shape stability is increased, and handling becomes easy.

In filter **65**, convex portions **79** protrude from frame body **69**, and the entire region of convex portions **79** can be fixed so as to be bonded to the surface to be fixed. Accordingly, a sufficient bonding area is obtained. When the surface of filter **65** is attached so as to be parallel with respect to the flow of air including removal materials, the front and rear convex portions **79** protrude from frame body **69** into the flow of the air. Accordingly, the flow of the air is not blocked by frame body **69**, the air directly abuts the surfaces of convex portions **79** also in the vicinity of frame body **69**, and easily comes into contact with the surfaces of convex portions **79**. Therefore, efficiency of capturing the ultrafine particles is increased.

In filter **65**, since the front and rear convex portions **79** protrude from frame body **69**, even when convex portions **79** are bonded so as to be fixed to the inner wall surface, ditches **77** opposing the inner wall surface are opened to air transport space **61** of duct **53**. That is, it is possible to allow the front and the rear of filter main body **67** to communicate with air transport space **61**. Therefore, according to filter **65** in which ditches **77** and convex portions **79** protrude from frame body **69**, a closed space is not generated between the filter and the inner wall surface, and thus, it is possible to increase the efficiency of capturing the ultrafine particles.

In filter **65**, ditches **77** and convex portions **79** extend so as to be orthogonal to the long-side direction of duct **53**. That is, ditches **77** and convex portions **79** are alternately disposed in the long-side direction of duct **53**. Container exhaust gas **87** flowing into air transport space **61** of duct **53** from exhaust port **63** of first side wall **57** flows toward the direction approaching ceiling surface **71** of the duct by ascending current including water vapor. Particularly, the flow in the direction approaching ceiling surface **71** of the duct is remarkably generated immediately after exhaust fan **49** is stopped. Container exhaust gas **87** approaching ceiling surface **71** of the duct abuts the surface of filter **65** attached to ceiling surface **71** of the duct. At this time, ditches **77** and convex portions **79** extend so as to be orthogonal to first side wall **57** on the surface of filter **65**. Accordingly, in filter **65**, container exhaust gas **87** flowing in the long-side direction of duct **53** after flowing from exhaust port **63** easily abuts convex portions **79**. Container exhaust gas **87** collides with convex portions **79**, and thus, turbulence is easily generated, and numerous vortexes are generated in the vicinity of filter **65**. As a result, in filter **65**, probability of capturing the ultrafine particles at minute voids of filter **65** itself is improved.

In filter **65**A, ditches **77**A and convex portions **79**A extend in the inclined direction in the long-side direction of duct **53**. As for the "inclination in the long-side direction of duct **53**", two inclination directions are considered. One inclination direction is an inclination direction (separation inclination direction) in which the inclination end of one end side (exhaust fan **49** side) in the long-side direction of the duct of ditch **77**A and convex portion **79**A positioned on ceiling surface **71** of the duct is away from first side wall **57**. On the other hand, the other inclination direction is an inclination direction (approach inclination direction) in which the inclination end of exhaust fan **49** side of ditch **77**A and convex portion **79**A positioned on ceiling surface **71** of the duct approaches first side wall **57**.

Initially, container exhaust gas **87** flowing toward exhaust fan **49** in air transport space **61** of duct **53** flows into duct **53** in a direction orthogonal to the long-side direction of duct **53** from exhaust port **63** of first side wall **57**. That is, the flow direction of container exhaust gas **87** is gradually curved from exhaust port **63**, and is changed into a perpendicular direction. Strictly speaking, the flow direction becomes three-dimensional complicated flow lines which interfere with one another.

When ditches **77**A and convex portions **79**A are in the "separation inclination direction", container exhaust gas **87** immediately after the container exhaust gas flows from exhaust port **63** easily flows to the downstream side without inversely flowing along the extension directions of ditches **77**A and convex portions **79**A. Accordingly, ditches **77**A and convex portions **79**A in the separation inclination direction easily come into contact with container exhaust gas **87** over the entire length in the extension direction. As a result, in the separation inclination direction, the time when ditches **77**A and convex portions **79**A come into contact with container exhaust gas **87** is lengthened.

Meanwhile, when ditches **77**A and convex portions **79**A are in the "approach inclination direction", container exhaust gas **87** immediately after the container exhaust gas flows from exhaust port **63** easily abuts the convex portions in a direction approximately orthogonal to the extension direction of convex portion **79**A. That is, container exhaust gas **87** collides with convex portions **79**A, turbulence is easily generated, and numerous vortexes are generated in the vicinity of filter **65**. As a result, in ditches **77**A and convex portions **79**A in the approach inclination direction, probability of the ultrafine particles being captured by the minute voids of filter **65** itself is improved.

Which of the approach inclination direction and the separation inclination direction can capture more ultrafine particles can be confirmed by measuring the amounts of emission of the ultrafine particles in the outlet side of exhaust fan **49**. As a result of the confirmation, it is understood that compared to the separation inclination direction, ditches **77**A and convex portions **79**A in the approach inclination direction increase efficiency of capturing the ultrafine particles.

In filter **65**B, ditches **77**B and convex portions **79**B extend so as to be parallel to the long-side direction of duct **53**. Container exhaust gas **87** flowing into air transport space **61** of duct **53** from exhaust port **63** of first side wall **57** flows toward the direction approaching ceiling surface **71** of the duct by ascending current including water vapor. Particularly, the flow in the direction approaching ceiling surface **71** of the duct is remarkably generated immediately after exhaust fan **49** is stopped. Container exhaust gas **87** approaching ceiling surface **71** of the duct abuts the surface of filter **65**B attached to ceiling surface **71** of the duct. At this time, ditches **77**B and convex portions **79**B extend so as to be parallel to first side wall **57** on the surface of filter **65**B. Accordingly, in filter **65**B, container exhaust gas **87** immediately after flowing from exhaust port **63** easily abuts convex portions **79**B with a wider surface area. Container exhaust gas **87** collides with convex portions **79**B, and thus, turbulence is easily generated, and numerous vortexes are generated in the vicinity of filter **65**B. As a result, in filter **65**B, probability of capturing the ultrafine particles at minute voids of filter **65**B itself is improved.

When ditches **77**B and convex portion **79**B extend so as to be parallel in the longitudinal direction of duct **53**, container exhaust gas **87** flowing toward one end side in the long-side direction of duct **53** flows along ditches **77**B and convex portions **79**B. Accordingly, it is possible to suppress an increase of resistance during the air is transported. As a result, it is possible to suppress an increase in output of exhaust fan **49** or noise (sound generated when the air passes through duct **53**).

As described above, various embodiments are described with reference to the drawings. However, it goes without saying that the present invention is not limited to the examples. It is clear to a person skilled in the art that various modifications and corrections may be applied within a scope described in claims, and various modifications and corrections are included in the technical range of the present invention.

According to the embodiments of the present invention, the present invention is useful as the image forming apparatus which decreases the amount of emission of the ultrafine particles and suppresses the increase in the output of the exhaust fan by the simple structure.

What is claimed is:

1. An image forming apparatus comprising:

a fuser unit including a heat roller and a pressure roller, which heats and pressurizes a sheet on which an unfused toner image is carried and fuses the unfused toner image on the sheet;

a duct formed in a long shape in a longitudinal direction along a longitudinal axis of the heat roller, which is disposed in the vicinity of the fuser unit along the longitudinal axis of the heat roller;

an exhaust fan provided adjacent to one longitudinal end of the duct;

an exhaust port, which is opened in a first side wall of the duct facing the fuser unit and causes the fuser unit and the duct to communicate with each other; and

a planar filter which is attached to an inner wall surface of the duct,

wherein the planar filter includes,

a filter base material having a surface shape in which ditches and convex portions are alternately disposed; and

a frame which is bonded to two opposing ends of the filter base material where both ends of each of the ditches and convex portions meet, respectively,

wherein the convex portion of the filter base material protrudes from the frame, and

wherein the convex portion of the filter base material is bonded or stuck to the inner wall surface.

2. The imaging forming apparatus of claim **1**, further comprising

a fuser unit container which accommodates the fuser unit,

wherein the first side wall is a portion of a wall of the fuser unit container.

3. The imaging forming apparatus of claim **1**,

wherein the planar filter is stuck to the inner wall surface of the duct so as to be parallel with the inner wall surface.

4. The imaging forming apparatus of claim **1**,

wherein the inner wall surface of the duct is a ceiling surface of the duct.

5. The imaging forming apparatus of claim **1**,

wherein in the surface shape the ditches and convex portions extend in a direction orthogonal to the longitudinal direction of the duct.

6. The imaging forming apparatus of claim **1**,

wherein in the surface shape the ditches and convex portions extend at an inclined angle to the longitudinal direction of the duct.

7. The imaging forming apparatus of claim **1**,

wherein in the surface shape the ditches and the convex portions extend in parallel to the longitudinal direction of the duct.

8. The imaging forming apparatus of claim **1**,

wherein a plurality of the exhaust ports are opened in the first side wall.

9. The imaging forming apparatus of claim **1**,

wherein a thru-beam type filter which passes exhaust emissions from the fuser unit is attached to an exhaust opening surface of the exhaust fan.

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